Irradiation Effects on Amorphous and Crystalline Water Ices

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Many experiments have been conducted to study the effects of irradiation on water ice. However, the relevant mechanisms are not so clear owing in part to possible contamination from residual gases inside the vacuum systems. Therefore, we are conducting a systematic study of the irradiation of water ice in an ultrahigh vacuum (back pressure around 1.0_10^{-10} torr). In our experiment, amorphous and crystalline water ices of about 200nm thickness were irradiated at different temperatures between 10 and 100 K with energetic electrons. The infrared absorption spectra of those water ice samples were measured with a FTIR spectrometer; the gaseous components were detected with a quadrupole mass spectrometer. Our studies show that H_2, O_2 and H_2O_2 were generated and trapped in water ice during the irradiation. H_2 came out from water ice when the samples were warmed up to 110 – 140 K; molecular oxygen emerged at 147 – 151 K. H_2O_2 started to sublime around 170 K. We interpret the results in terms of detailed reaction mechanisms so that general concepts on the irradiation induced water chemistry can be derived. The changes of infrared absorption features indicated that the crystalline water ices were amorphized partially by irradiation. Those results might help the understanding of the cosmic ray processing of water ices in the interstellar medium as well as the cosmic ray and solar wind processing of water ices in the Kuiper Belt Objects, comets, planetary surfaces and satellite surfaces.